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AUTHOR	Pawlowski, Jan M.
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ABSTRACT

Standardization initiatives in the field of learning technologies have produced standards for the interoperability of learning environments and learning management systems. Learning resources based on these standards can be reused, recombined, and adapted to the user. However, these standards follow a content-oriented approach; the process of applying pedagogical concepts is not covered by these standards. In recent years, several approaches for pedagogical and didactical concepts have emerged, but their use within a framework of standards has not yet been consistently resolved. In this paper, a model is presented which combines pedagogical and content-oriented design. The model, based on the Essen Learning Model, is a basis for the reuse and recombination of pedagogical expertise. (Contains 17 references, 3 figures, and 1 table.) (Author)

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Reusable Models of Pedagogical Concepts - a Framework for Pedagogical and Content Design

Jan M. Pawlowski

Information Systems for Production and Operations Management
University of Essen, Germany
jan.pawlowski@wi-inf.uni-essen.de

ED 477 081

Abstract: Standardization initiatives in the field of learning technologies have produced standards for the interoperability of learning environments and learning management systems. Learning resources based on these standards can be reused, recombined, and adapted to the user. However, these standards follow a content-oriented approach. The process of applying pedagogical concepts is not covered by these standards. In the last years, several approaches for pedagogical and didactical concepts have emerged, but their use within a framework of standards is not yet consistently solved. Therefore, a model is presented which combines pedagogical and content-oriented design. The model, based on the Essen Learning Model, is a basis for the reuse and recombination of pedagogical expertise.

Introduction

Development processes of learning environments have changed significantly in the last years. The enormous cost for multimedia production led to the consequence that a high amount of end-users are necessary to be efficient. Learning resources have to be adapted and updated in shorter periods of time. Furthermore, learning environments must be individually tailored to the users needs and preferences in order to optimize the learner's performance.

Standardization is a means to ensure interoperability between systems. Both, learning management systems and learning environments have been subject of standardization initiatives. These initiatives, such as IEEE Learning Technology Standards Committee (LTSC), Instructional Management Systems (IMS)-Project, or the Advanced Distributed Learning Network (ADLNET) have developed a broad range of standards, from high-level specifications for architectures to bindings for certain components. However, most of these approaches focus on the reuse of content. These specifications do not provide adequate concepts for modeling pedagogical concepts. As a consequence, several approaches of pedagogical models, such as Educational Modeling Language (EML) or Tutorial Modeling Language (TML) are being developed. These models cannot be seen as a substitute for content-oriented standards. Moreover, a framework for the combination of content-oriented standards and pedagogical approaches is needed to model a complex learning environments.

In this paper, an approach is presented providing a framework for the description of pedagogical and didactical concepts. The approach is based on the Essen Learning Model (ELM). ELM is a development model for the development of learning environments. It provides support for developers, designers, content providers, teachers, and learners on various levels. Processes and activities in project management, quality assurance, curriculum development, course design, and implementation are supported. Furthermore, the specification of learning technology standards is integrated in this model.

First of all, related standards are presented. It is shown how these standards provide a framework for the interoperability of learning environments. Secondly, related approaches for pedagogical concepts are presented. Furthermore, an introduction to relevant aspects of the Essen Learning

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Model is given. We focus on the aspects of modeling pedagogical concepts. As a conclusion, further research activities are suggested.

Learning Technology Standards

Learning Technology Standards are being developed by several initiatives. In this section, the relevant standards for learning environments are presented. Currently, two standards have reached a high level of maturity (Pawlowski, Adelsberger 2001a, Pawlowski 2001): Learning Object Metadata (LOM) and the Sharable Content Object Reference Model (SCORM).

Learning Object Metadata (LOM) is a standard by the IEEE Learning Technology Standards Committee (LTSC) for the description of learning resources (LTSC 2001). LOM are used to describe learning resources, such as learning environments. For this purpose, nine categories are included: General, Lifecycle, Meta-Metadata, Technical, Educational, Rights, Relation, Annotation, and Classification. This standard is useful to describe general characteristics of learning environments to facilitate search, retrieval, and reuse of learning resources. However, the description of educational aspects is limited to a generalized summary (e.g., interactivity type, learning resource type, interactivity level). This classification cannot be used to represent detailed information on pedagogical and didactical concepts used in a learning environment.

The Sharable Content Object Reference Model (SCORM) (Dodds 2001a, Dodds 2001b) by the *Advanced Distributed Learning Network (ADLNET)* is a standard to ensure interoperability between Learning Management Systems (LMS) and learning environments. SCORM integrates LOM and the content aggregation model which is a standard to represent the structure of a learning environment and relations of learning units. The run-time environment in SCORM is the interface between LMS and learning environments. It controls the sequence of a learning environment by integrating the Computer Managed Instruction (CMI) standard (LTSC 2000). This standard can be used to represent courses and learning environments. However, the focus of this standard is to combine and control learning environments. The main aspect is to model content and its structure. Although the structure can implicitly contain a pedagogical approach, no pedagogical concept is used to determine the structure, navigation, or other adaptations.

Both standards serve as a base for interoperable description and reuse of learning environments and learning resources. However, these standards need individual extensions in order to apply pedagogical concepts.

Pedagogical Models

The current representation of metadata such as LOM does not provide an adequate representation of pedagogical concepts (Koper 2001, Pawlowski 2001). Additionally, there is no adequate mapping of content-oriented representation to a pedagogy-oriented representation. A variety of models have been developed in order to close this gap.

The *Tutorial Markup Language (TML)* (Netquest 2000) is a markup language for the development of tutorial systems. Questing and problem-solving scenarios can be specified through questions, answers, rules, and help functions. It is possible to develop simple tutorial systems. However, only certain didactical approaches can be realized using TML.

The *Instructional Material Description Language (IMDL)* (Gaede 2000) represents structure, content, assessments, metadata, and a learner profile. The approach strictly follows an instructional design approach. Therefore, it restricts the pedagogical design. It is not flexible enough to model any given pedagogical approach.

A promising approach for the representation of pedagogical concepts is the Educational Modeling Language (EML) (Koper 2001) which is based on a meta-model for pedagogical modeling. It focuses on the embedding of learning resources in a pedagogical context. The metamodel consists of four components:

- *Theories of learning and instruction* describe theories, principles, and models of learning and teaching. The model distinguishes between empiricist, rationalist, pragmatist-sociohistoric, and eclectic theories.
- The *Learning Model* describes the interactions of learners in specific learning situations.
- The *Domain Model* represents the domain in which a learning environment is used.
- The *Unit of Study Model* describes the design of learning units depending on learning theories, learner models and domain models. The following categories are included in this model: Unit-of-study, Metadata, Roles, Learning-objectives, Prerequisites, Content, Activity, Environment, Method.

EML provides a promising representation of content and pedagogical concepts. Currently, there is no mapping to other standards such as SCORM. In order to use both standards, a common framework must be specified.

Essen Learning Model (ELM)

ELM Development Model

The Essen Learning Model is a modular system (Fig. 1) supporting development processes as well as the system's use on different levels: the support of curriculum design (C-level), the development of learning sequences (D-level), and the development of learning units (E-level) (Adelsberger, Bick, Pawlowski 2000, Pawlowski, 2000, Pawlowski, 2001). Three abstraction levels can be distinguished: The *generic development model* provides knowledge for a variety of contexts. This generic model is customized depending on the users' needs and preferences, and transformed into a specific process model for each development project. The *process model* is implemented using the Architecture of Integrated Information Systems (ARIS) and provides a framework for educational technology projects. ARIS is a frame concept for a global description (modeling) of computer supported information systems, covering the whole life-cycle range - from business process design to information technology deployment (Scheer, 1998). The third level is the *result* of the development process in the form of certain implementations for each module.

Figure 2 represents the main processes of the Essen Learning Model. The result of ELM-C is a detailed network of learning objectives and goals, determining structure and relations of learning sequences (e.g. courses). Based on these results, learning sequences are developed in ELM-D. The focus of this phase is to find an adequate didactical method together with the right technology depending on learning objectives and user groups. Finally, single learning units are designed and implemented in ELM-E, using the Extensible Markup Language (XML).

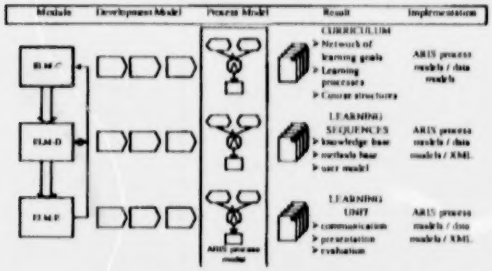

Fig. 1: The Essen Learning Model

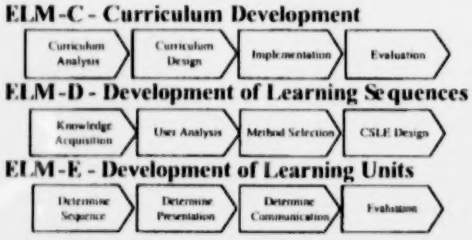

Fig. 2: Main process of ELM

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Modeling Pedagogical Concepts in ELM

Modeling pedagogical concepts mainly consists of three processes in ELM:

Context Modeling: Learning cannot be separated from the context. The context includes the environment of the learner (e.g., institution, organization, company) and the learner's experiences and knowledge. The context is analyzed on two levels: A description of the learner's characteristics and preferences and the organization the learner is involved in.

Content Modeling: The content of a learning environment is described on three levels: learning sequences, composite learning units, and learning units. These levels correspond to the structure of SCORM (Content, Block, Sharable Content Object).

Didactical Modeling: Didactical concepts are directly related to the leaner (actor), learning objectives, learning setting, and the description of a method (see Fig. 3). The description of a method consists of phases (activities) which can be grouped to phase blocks. Furthermore, experiences and the usability of a method for certain content, settings, or learning objectives is described (see Bick, Pawlowski, Veith 2001). By this description, a knowledge base for didactical methods is created. Designing a learning environment means that the context, content, and didactical method must be related. As an example, the method "simulation game" consists of the phases introduction, motivation, activity/interaction, reflection, abstraction, and analysis/feedback. These phases are mapped to learning units. The mapping of learning units to phases provides the connection between the pedagogical model and the content model (e.g., SCORM).

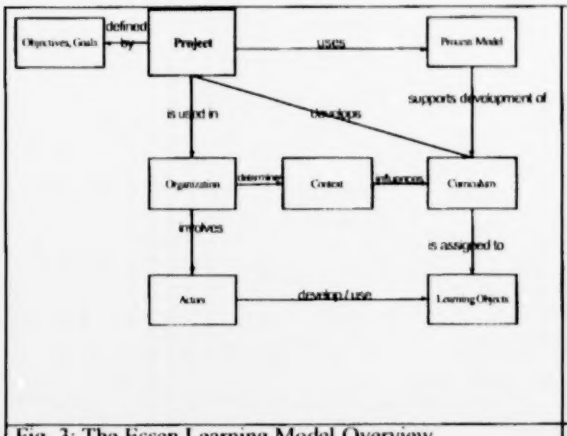

Fig. 3: The Essen Learning Model Overview

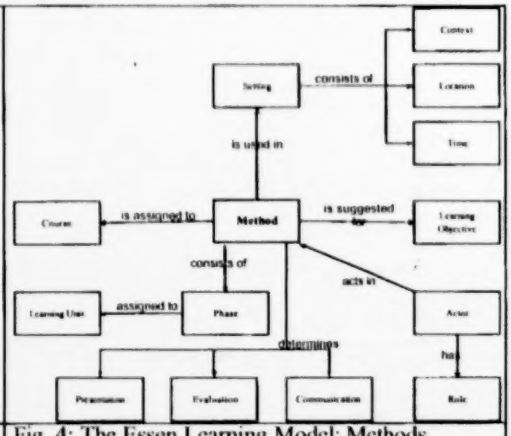

Fig. 4: The Essen Learning Model: Methods

The model of a pedagogical concept consists of the three main components (context, content, and method). In Table 1 the information model for methods is described.

Table 1: Information Model Method

Category	Description
General Data	
Dublin Core	Dublin Core-Elements
Reference	Reference to external information model

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Category	Description
Description	
Name	Name of the method
Source	Source of the method
Recommendation	Recommendation for context, learning objectives, content, actor
Template	Reference to a template, template format
Setting	
Context	Reference to context specification
Location	Location, Distribution
Time	Period, temporal restrictions
Phases	
Phase	Name of a phase of the method, aggregation
Kind	Kind of a phase (grouping to phase blocks)
Sequence	Relation to other phases, sequence, schedule, sequence operator (linear, parallel, free)
Runs	Repetitions of a phase
Interaction	
Description	Description of intended / possible interactions
Role	Role of participating actors, description of role
Type	Type of interaction
Topology	Unidirectional, bidirectional
Kind	Synchronous, asynchronous
Applications	Communication applications/systems
Reference	Reference to external interaction specification
Presentation	
Type	Type of presentation object
Applications	Presentation application
Reference	Reference to external presentation specification
Evaluation	
Kind	Kind of evaluation (Test, Scenario, ...)
Applications	Reference to evaluation application
Evaluation	Reference to learning object evaluation

Conclusion

In this paper, the weaknesses of current standards have been identified. Learning technology standards such as LOM and SCORM focus on content-oriented models of learning. The representation of pedagogical concepts is neglected in these model. It has been shown that most existing pedagogical models do not provide a generic representation for pedagogic expertise. The Educational Modeling Language (EML) is a step towards a generic representation. However, pedagogical specifications and other existing standards need to be mapped into a common framework. The Essen Learning Model provides this framework by integrating existing standard with a generic pedagogical model. This model serves as a base for a high-quality design of learning environments from a pedagogical and content perspective.

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